

NATURAL RESOURCES CONSERVATION SERVICE
CONSERVATION PRACTICE STANDARD
CONSERVATION CROP ROTATION

(Ac.)

CODE 328

DEFINITION

A planned sequence of crops grown on the same ground over a period of time (i.e., the rotation cycle).

PURPOSE

This practice may be applied to support one or more of the following purposes:

1. To reduce sheet, rill, and/or wind erosion;
2. To maintain or increase soil health and organic matter content;
3. To reduce water quality degradation due to excess nutrients;
4. To improve soil moisture efficiency;
5. To reduce plant pest pressures;
6. To provide feed and forage for domestic livestock;
7. To provide food and cover for wildlife, including nesting habitat and pollinator forage.

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to all cropland where at least one annually-planted crop is included in the crop rotation.

CRITERIA

General Criteria Applicable to All Purposes

Crops shall be grown in a planned sequence as specified in the conservation plan and/or Implementation Requirements worksheet. The crop rotation shall include a minimum of two different crops. For purposes of these criteria, a cover crop is considered a different crop.

Crops shall be adapted to the climatic region, soils, and goals of the producer. Select adapted crops and varieties, listed in appropriate university publications or other approved sources.

Where applicable, plan suitable crop substitutions when the planned crop cannot be planted due to weather, soil conditions, or other local situations.

Additional Criteria to Reduce Sheet, Rill, and/or Wind Erosion

Select crops, a tillage system, and cropping sequences that will produce sufficient and timely quantities of biomass or crop residue which, in conjunction with other practices in the management system, will reduce sheet, rill and wind erosion to the planned soil loss objective.

Determine the amount of biomass or crop residue needed by using current approved erosion prediction technology.

Additional Criteria to Maintain or Increase Soil Health and Organic Matter Content

Grow crops that will produce a positive trend in the Organic Matter (OM) subfactor value over the life of the rotation as determined by the Soil

Conditioning Index. Make appropriate adjustments for additions to or subtractions from biomass.

Additional Criteria to Reduce Water Quality Degradation Due to Excess Nutrients

Determine crop selection and sequence according to an approved nutrient balance procedure. Credit nutrients provided by legumes and manure/compost.

To recover excess nutrients from the soil profile, use crops with:

1. Quick germination and root system formation;
2. A rooting depth sufficient to reach the nutrients not removed by the previous crop; and,
3. Nutrient requirements that readily utilize the excess nutrients.

Additional Criteria to Improve Soil Moisture Efficiency

Select crops, varieties of crops, and the sequence of crops based on local climate patterns, soil conditions, irrigation water availability, and an approved water balance procedure.

Additional Criteria to Reduce Plant Pest Pressure

Plant pests may include weeds, insects, and pathogens. Design the crop sequence to suppress pest lifecycles and/or to allow the use of a variety of control methods. Use appropriate university publications or other approved sources to determine a suitable crop sequence. When there is a history of pest problems, select resistant varieties to the extent feasible.

Remove susceptible crops and alternate host crops from the rotation for the period of time needed to break the life cycle of the targeted pest.

Control noxious weeds as required by Delaware State Law.

Additional Criteria to Provide Feed and Forage for Domestic Livestock

Select crops that balance the feed supply with livestock numbers. Determine the required amount of selected crops using an approved forage-livestock balance procedure.

Additional Criteria to Provide Food and Cover for Wildlife, including Nesting Habitat and Pollinator Forage

Select the crops and crop management activities that provide either food or cover for the targeted wildlife species.

Note: Specific programs or other funding sources may dictate criteria in addition to, or more restrictive than, those specified in this standard.

CONSIDERATIONS

Additional Considerations to Increase Cropping System Diversity

For crop diversity, the planned crop sequence should contain different crop types, such as warm season grass, warm season broadleaf, cool season grass, and cool season broadleaf. For example:

1. A two-crop sequence that contains a warm season and a cool season crop. (Example - vegetables-cover crop);
2. A three-crop sequence that contains warm and cool season crops. The same crop species should not be grown in successive years in the same field. (Example - corn-small grain-soybeans);
3. A four-crop sequence that contains two different crop types. Neither should occupy more than half of the sequence. (Example - corn-small grain-soybeans-cover crop);
4. Longer crop sequences (four or more years) are more effective, with no more than two consecutive years with the same crop. (Example, corn-corn-small grain-soybeans-vegetables-cover crop).

Additional Considerations to Reduce Sheet, Rill, and/or Wind Erosion

Selection of high-residue producing crops and varieties, use of cover crops, and adjustment of plant density and row spacing can enhance production of the kind, amount, and distribution of residue needed to reduce erosion.

Crop damage by wind erosion can be reduced by selecting crops that are tolerant to abrasion from wind blown soil or tolerant to high wind velocity.

If crops sensitive to wind erosion damage are grown, the potential for plant damage can be reduced by crop residue management, field windbreaks, herbaceous wind barriers, intercropping, or other methods of wind erosion control.

Additional Considerations to Maintain or Increase Soil Health and Organic Matter Content

Maintaining or improving soil organic matter content can be enhanced by increasing or retaining crop residues and reducing tillage. In addition, animal wastes, green manure crops (cover crops), or mulch may be applied to supplement the biomass produced by crops in the rotation.

Soil compaction can be reduced by adjusting crop rotations to include crops with deep roots that extend to and penetrate compacted soil layers. Avoid field operations when the soils are wet.

For rotations dominated by low-residue crops, such as vegetables, consider using cover crops and high residue crops for at least half of the rotation.

Considerations to Reduce Water Quality Degradation Due to Excess Nutrients

Include perennial or annual legume crops in the rotation to provide nitrogen for non-legume crops, especially in fields where manure applications are restricted by high or excessive soil phosphorus or potassium levels.

Select crop and management strategy to match nitrogen release from residues of the nitrogen

fixing crop with nitrogen uptake by the subsequent crop, taking into account climate, soil physical and chemical properties, C:N ratio of residues of the nitrogen fixing crop, and timing of nitrogen demand by the subsequent crop.

Use a carbon/nitrogen ratio of 25:1 to 35:1 for crop residues returned to the soil throughout the rotation. This ratio can build the soil's capacity to provide slow-release N to crops while minimizing N leaching.

Additional Considerations to Reduce Plant Pest Pressures

Consider using cover crops to suppress annual and some perennial weeds. Cover crops can reduce pest pressure by providing residue or green manure on the soil surface, direct competition, and allelopathic properties.

Consider lengthening the rotation to include several years of perennial cover to break pest life cycles.

Use a mix of crops from at least three different plant families, and allow three years or longer between successive plantings of production crops within the same family.

Where pesticides are used, use a combination of pesticide application methods and crop rotation to reduce the potential for pesticide carryover or adverse affects on aquatic wildlife or habitat through runoff.

Biological control of various crop pests can be provided by:

1. Crop rotations that include flowering annuals or perennials, such as buckwheat or clover, that provide food and habitat for beneficial insects;
2. The use of plant species that release into the soil natural substances that suppress plant pathogens, nematodes, or pests (bio-fumigation);
3. The use of crops in the rotation or in field borders that provide habitat for natural enemies of pests; and,

4. Intercropping of species that provide pollinator forage and reproductive habitat for beneficial insects.

Additional Considerations to Provide Food and Cover for Wildlife, including Nesting Habitat and Pollinator Forage

Crop plantings may be developed to benefit particular communities, species, or life stages of wildlife. Food plots for wildlife may be used as part of habitat restoration to provide initial food and cover until long-term vegetation becomes established.

Careful consideration should be given to pesticides that may be applied to crops raised for wildlife, particularly if nesting habitat or pollinator forage species are present.

To maintain stable pollinator and beneficial insect populations, ensure that the same overall density of floral resources is maintained from year-to-year. For example, two years of flower-rich plantings, followed by a year of only grasses, will cause a rapid decline in pollinator populations.

PLANS AND SPECIFICATIONS

Plans and specifications for this practice shall be prepared in accordance with the previously listed criteria. Plans and specifications shall contain sufficient detail to ensure successful implementation of this practice, and may be recorded in narrative form on Implementation Requirements (IR) worksheets, fact sheets, or other approved forms.

The appropriate fact sheet(s) and completed 328 IR worksheet can serve as the plan and specifications for this practice.

The following components shall be included:

1. Purpose(s) of the crop rotation;
2. Field number and acres;
3. The sequence of crops to be grown;
4. The crop types to be grown;

5. Length of time each crop/crop type will be grown in the rotation;
6. Total length of rotation;
7. Planned soil loss and/or Soil Conditioning Index (SCI) value, if applicable;
8. Statement that crop substitutions may be made to address weather, soil conditions, market, or other situations that may prevent the planned crop from being planted.

OPERATION AND MAINTENANCE

An Operation and Management (O&M) plan shall be prepared and is the responsibility of the client to implement. The appropriate fact sheet(s) and IR worksheet may serve as the management plan, as well as supporting documentation, and shall be reviewed with and provided to the client.

At a minimum, the following components shall be addressed in the O&M plan, as applicable:

1. Follow the specified crop rotation for each field. Contact NRCS before changing the rotational cropping sequence and/or tillage methods, especially on HEL fields or when receiving financial assistance for this practice;
2. Evaluate the rotation and the cropping sequence to determine if the system is meeting the intended purposes(s). Substitute crops may be used in case of crop failure or for weather-related or economic reasons. Acceptable substitutes are crops that will accomplish the purpose of the original crop;
3. Where wildlife habitat is a concern, the following management techniques can help provide food and cover for wildlife, including nesting habitat and pollinator forage:
 - a. Carefully consider the toxicity levels of all pesticides applied to crops, particularly if wildlife nesting habitat and/or pollinator forage species are present. To the extent feasible, select pesticides that have low toxicity for pollinators and other wildlife;
 - b. Leave several rows unharvested around the edges of the field, or plant borders of

various forbs to provide protection and/or food for overwintering wildlife and for beneficial insects and pollinators;

- c. Retain bolting or flowering crops after harvest to provide beneficial insects with an important food source when pests are active;
- d. When insect-pollinated crops are part of the rotation, plant them no more than 800 feet from their previous location to help maintain local populations of native bees that may have become established because of the presence of that crop.

SUPPORTING DATA AND DOCUMENTATION

The following is a list of the minimum data and documentation to be recorded in the case file:

1. Location of the practice on the conservation plan map;
2. Assistance notes. The notes shall include dates of site visits, name or initials of the person who made the visit, specifics as to alternatives discussed, decisions made, and by whom;
3. Soil loss calculations (RUSLE2 printouts), if erosion control is a purpose;
4. Soil Conditioning Index (SCI) value or SCI/STIR reference table, if soil health or organic matter is a purpose;
5. Completed IR worksheet, and copy of the appropriate fact sheet(s) or other specifications and management plans.

REFERENCES

1. Green, B., D. Kaminski, B. Rapp, M. Celetti, D. Derksen, L. Juras, and D. Kelner. 2005. *Principles and Practices of Crop Rotation*. Saskatchewan Agriculture and Food.
2. Karlen, D.L., E.G. Hurley, S.S. Andrews, C.A. Cambardella, D.W. Meek, M.D. Duffy, and A.P. Mallorino. 2006. *Crop Rotation Effects on Soil Quality at Three Northern Corn/Soybean Belt Locations*. Agron. J. 98:484-495.
3. Liebig, M.A., D.L. Tanaka, J.M. Krupinsky, S.D. Merrill, and J.D. Hanson. 2007. *Dynamic Cropping Systems: Contributions to Improve Agroecosystem Sustainability*. Agron. J. 99:899-903.
4. Sherrod, L.A., G.A. Peterson, D.G. Westfall, and L.R. Ahuja. 2003. *Cropping Intensity Enhances Soil Organic Carbon and Nitrogen in a No-till Agroecosystem*. Agron. J. 67:1533-1543.
5. USDA, Natural Resources Conservation Service. *Conservation Practice Standards*. Delaware Field Office Technical Guide, Section IV.